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Prediction of transport infrastructure financing needs based on precedences

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Abstract

This article solves analyzing and modeling of transport infrastructure financing needs based on precedence analysis. Precedence is calculated for the infrastructure of the selected region and selected segmentation applied in smaller regional units. Based on comparison of progress of the precedence of transport infrastructure at various time intervals and development of precedence in the infrastructure funding are sought consensus and disproportion in the precedence. Development of transport is determined by the state inspection infrastructure concepts and strategies for transport policy. These concepts are continually updated. Based on changes in the design there can be determined another precedence. Precedence in transport infrastructure may be affected by various combinations of selected segments of transport routes. For this reason, different precedence may exist. To determine the precedence it is important do correct choice of threshold values of important qualitative and quantitative attributes. Based on combination of values for these attributes are compared development of the precedence in the past and there are searched consensus in the precedence of development infrastructure, in the precedence of concepts changes and in the precedence infrastructure funding. Setting appropriate thresholds and mutual functional dependencies among individual attributes are predicted requirements for infrastructure funding. Prediction is based on planning changes in transport infrastructure which are modified based on individual precedence in concepts changes.

Keywords: transport infrastructure; roads; highways; finance; budget; precedence; compared.

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1. Introduction

This paper introduces the possibilities of prediction of available resources and the funding of transport infrastructure. The analysis is simplified to road infrastructure only (in some cases also to rail infrastructure) due to the large scale of the problem. Predictions related to funding are made on the model of the Czech Republic segmented into regions. The problem can be narrowed mainly to road infrastructure, because it is the dominant one (European Environment Agency, 2010). Similar analyses are common, but they are mostly just financial summaries and standard economic analysis, for example (Forsyth, 2010). Precedence analysis is based on the fundamental definition of general system. A system is defined as a set of elements and relationships among them. Each element has a set of attributes. Precedence analysis compares values of selected attributes between elements with defined relationship. Compared could be absolute values of attributes or purposefully defined changes of values such as relative or absolute increase in time, relative or absolute increase in space, deviations from the average, maximum and minimum values, etc. Directions of flow of the values of selected attribute between arbitrarily defined pairs of elements can be obtained by comparing these values. The precedence and the succession are then determined on the basis of this flows according to the values of attributes in the system. These precedencies and successions can be processed with existing mathematical apparatus, which was described by (Borje, 1981). Stated apparatus has been further developed by (Diestel, 2005), who described some applications in the field of graph theory, by (Bakhsi, 2008) or by (Unčovský, 1991). It is obvious that this paper presents a partial analysis and introduces the possibilities of non-standard methods (Botlík, 2013).

2. Terms and methodologies

2.1. Precedence analysis

If we consider the mere existence of links in the system, we get an matrix apparatus which is working mainly with binary matrices. Theory can be extended to numerical matrix, which can be often converted by decomposition to binary (it is not always possible, however, it is not always appropriate).These types of links can be capture using by the precedence matrix **P**, where p_{ij} is equal to "1" if the row element precedes column element. Generally, we can determine predecessors of any type of object. Borje (1981) refers to $\mathbf{P^{00}}$, $\mathbf{P^{11}}$, $\mathbf{P^{10}}$ $\mathbf{P^{01}}$. Besides these matrices there are often used flow matrix to analyze something, which Borje (1981) described as $\mathbf{E^{10}}$. Above the matrices it can be defined very easily general operations, selection and composition. Find a group of precursors for binary matrix is made that the compositions used for the operation of unification.

Standard operation known as matrix multiplication and vector $\mathbf{P}\,\boldsymbol{s}$ ($\mathbf{P}\boldsymbol{s} = \boldsymbol{s}'$). If we use a sample column vector of arbitrary precedence matrix, we obtain as a result of the vector, which we have another precedence matrix to the appropriate vector of matrix (in the matrix is in the column / in column vector / value "1" in place of predecessors and result are predecessors to this vector). If we gradually carry out this operation with all the column matrix, we obtain as a result of the matrix indicating the type of precedence, it is the matrix of another precedence. Appropriate operation is known as matrix multiplication and it is denoted $\mathbf{PP} = \mathbf{P^2}$. Similarly, we calculate the general n-th precedence as precedence of n-first precedence. Matrices are known as pVRs of the precedence matrix. $\mathbf{P}\ \mathbf{P^2} = \mathbf{P^3}$, $\mathbf{P^4} = \mathbf{P}\ \mathbf{P^3}$, ... $\mathbf{P}\ \mathbf{P^{n-1}} = \mathbf{P^n}$. If we find the matrix $\mathbf{P^k}$, which is not even one "1", then the k-1 indicates the longest path in the system unit. If you cannot find pVR, then the system contains a cycle

2.2. Model

Model is based on segmentation of the Czech Republic to the regions; elements are defined on various distinguishing levels according to funding and analyzed infrastructure. In case of regions the precedence matrix has a size of 15x15 elements, entries corresponds to the individual regions and relations are formed by the borders of the regions. The distinguishing level can be change by modifying the size and relationships in the matrix (for example according to the number of municipalities in the region).

2.3. Road division and administration

The categorization of road communications (RMD CR, 2012 b), their construction, conditions of usage and their protection, rights and obligations of the owners and the users of road communications, and the execution of the State administration in matters of road communications by appropriate road administrative authorities is regulated by Act No. 13/1997 Coll. on road communications in the valid wording (RMD CR, 2012 a). Road communications are divided into individual categories. Motorways are a road communications designed for a fast-moving long distance and international traffic by road motor vehicles, they are constructed without crossings at grade and accessible only to road motor vehicles with maximum permissible speed not less than provided by a special regulation. The next category are roads which constitute a road network. Road communications are accessible to public and designed for the use by road and other vehicles and pedestrians. Roads are divided into three classes, some of the first class roads are referred to as "expressways". The first class roads are designed especially for long-distance and international traffic. The second class roads are designed for traffic between districts and third class roads are designed for linking communities or for their linking to other road communications.

The ownership and management of road communications. On the basis of these rights analysis can be performed at national, regional, municipal and private entities level. The State is the owner of motorways and roads, the ownership rights are by law exercised by the Ministry of Transport and Communications, the exercise has been authorized to contributory organization Road and Motorways Directorate of the Czech Republic. The owner of second and third class roads is the appropriate regional body. The owner of local road communications is the municipality on the territory of which the local communications are situated. The owner of special road communications is a natural person or a legal entity. In matters of motorways, roads, local communications and a special communications with public access, the state administration shall be executed by road administrative authorities

3. Definition of transport precedences

To demonstrate the method in this article was created model based on the regions of the Czech Republic. Individual region forms element of the system. The links are defined when the regions adjacent or the regions adjacent with the environment. The links among elements are expressed by incidence matrix. Based on the data of Directorate of roads and highways and length of relevant roads categories (RMD CR, 2013) there were calculated percentage ratios for each category (Table 1, own processing, initial data: www.rsd.cz). Finally the two qualitatively different groups were compared, the sum of motorways (MW) and highways (expressways) (HW), (MW+HW) and roads for the sum of first, second and third category.

Table 1. Percentage calculation for creation of precedence, precedence determination based on percent, the names of regions in the Czech language (MW – motorways, HW – highways)

	percent of roads – total					percent of regions – total				
regions	MW	HW	I. class	II. class	III. class	MW	HW	I. class	II. class	III. class
Praha	12.69	40.24	11.62	35.45	0.00	1.44	7.96	0.17	0.20	0.00
Středočeský	2.02	1.58	6.86	24.63	64.92	26.46	36.02	11.34	16.22	18.33
Jihočeský	0.25	0.12	10.67	26.82	62.14	2.10	1.75	11.21	11.23	11.16
Plzeňský	2.13	0.00	8.21	29.25	60.42	14.88	0.00	7.22	10.25	9.08
Karlovarský	0.00	1.33	10.16	22.93	65.58	0.00	6.46	3.58	3.22	3.95
Ústecký	1.25	0.29	11.42	21.56	65.47	7.17	2.91	8.23	6.19	8.06
Liberecký	0.00	0.92	12.79	20.06	66.23	0.00	5.26	5.32	3.32	4.71
Královéhradecký	0.45	0.00	11.78	23.67	64.12	2.29	0.00	7.62	6.10	7.09
Pardubický	0.24	0.09	12.67	25.33	61.66	1.20	0.73	7.83	6.23	6.51
Vysočina	1.81	0.00	8.38	32.15	57.66	12.60	0.00	7.33	11.20	8.62
Jihomoravský	3.00	0.58	9.39	32.90	54.13	18.33	6.11	7.21	10.07	7.11
Olomoucký	0.93	2.54	9.65	25.91	60.97	4.52	21.43	5.90	6.31	6.37
Zlínský	0.58	0.75	15.99	26.76	55.92	1.70	3.79	5.87	3.91	3.51
Moravskoslezský	1.56	0.93	19.02	23.58	54.91	7.29	7.58	11.19	5.53	5.52

These data are currently incomplete and are added according to the maps and the planned construction of a road crossing, etc. Table 2 shows the development of roads in the years 2009, 2011 and 2013 (Data from Road and Motorway Directorate of the Czech Republic). The decomposition of the system to the individual regions is used for further analysis. Structures were segmented to highways, expressways, first, second and third class roads and related constructions for secure connections of backbone and local infrastructure. The increases in values of selected transport structures were successively analyzed in the defined system and weights of individual types of transport structures were determined.

Table 2. Overview of lengths of roads and highways in various regions on year 2009

Year	Region	Motor ways	Express ways	first class roads	second class roads	third class roads	Overall
2009	Praha	11	22	11	30	0	74
	Středočeský	194	140	655	2368	6255	9612
	Jihočeský	15		661	1637	3816	6129
	Plzeňský	109		421	1502	3097	5129
	Karlovarský		15	212	471	1354	2052
	Ústecký	53	13	477	907	2752	4202
	Liberecký		22	310	487	1608	2427
	Královéhradecký	17		437	893	2421	3768
	Pardubický	7	3	456	912	2221	3599
	Vysočina	93		425	1630	2942	5090
	Jihomoravský	134	28	418	1474	2440	4494
	Olomoucký	22	91	350	923	2185	3571
	Zlínský	7	3	339	574	1199	2122
	Moravskoslezský	28	32	672	766	1897	3395
2011	Praha	10.6	33.6	9.7	29.6	0	83.5
	Středočeský	194.2	152.1	661.2	2373.2	6256.2	9637
	Jihočeský	15.4	7.4	653.7	1643.8	3808.6	6128.8
	Plzeňský	109.2	0	420.9	1500	3098.8	5129
	Karlovarský	0	27.3	208.7	470.9	1346.9	2053.8
	Ústecký	52.6	12.3	480.2	906.4	2751.8	4203.3
	Liberecký	0	22.2	310.2	486.6	1606.2	2425.3
	Královéhradecký	16.8	0	444.3	892.9	2419	3772.9
	Pardubický	8.8	3.1	456.5	912.4	2220.8	3601.7
	Vysočina	92.5	0	427.4	1639.5	2940.2	5099.6
	Jihomoravský	134.5	25.8	420.8	1474	2425	4480.1
	Olomoucký	33.2	90.5	344.1	923.8	2174.3	3565.9
	Zlínský	12.5	16	342.1	572.6	1196.7	2140
	Moravskoslezský	53.5	32	652.5	809	1884.2	3431.2
2013	Praha	10,6	33,1	9.4	29,9	--	83.0
	Středočeský	194,2	152,1	669.4	2377,6	6248.2	9641.6
	Jihočeský	15,4	6,7	651.6	1633.4	3818.9	6126.1
	Plzeňský	109,2	--	418.8	1502,0	3095.8	5125.8
	Karlovarský	--	39.9	196.7	459.4	1354.1	2050.1
	Ústecký	56,5	12.3	478.0	898,2	2754.6	4199.6
	Liberecký	--	22.2	311.5	486.9	1591.5	2412.0
	Královéhradecký	16,8	--	439.2	893.4	2419.8	3769.1
	Pardubický	8,8	3.1	453.7	912.3	2219.7	3597.6
	Vysočina	92,5	--	427.4	1627.5	2935.5	5082.9
	Jihomoravský	134,5	25.8	422.1	1468.2	2416.8	4467.5
	Olomoucký	36,2	90.5	347.1	923.5	2170.1	3567.4
	Zlínský	16,6	16.4	342.1	512.0	1252.6	2139.8
	Moravskoslezský	59,9	39.9	641.0	818.5	1894.7	3454.0

Orientation of the links in the system was designed for these groups by comparing the percent of adjacent regions. Orientation of the links has been set for this post exhaustively based on the average percentage changes in the group. For each group the Incidence matrix was transferred to the Precedence matrix.

During the transfer of the precedence matrix, there was controlled the correctness of the system. Next set of precedencies is based on the comparison of the length of individual roads in observed intervals (Fig.1).

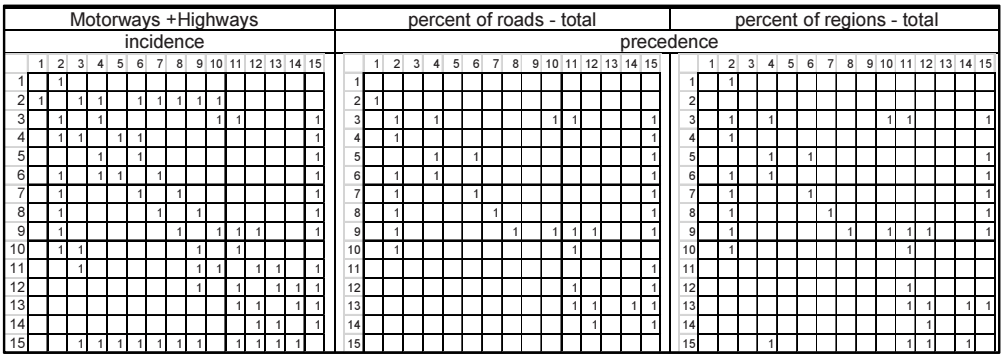

Fig. 1. Transformation Incidence matrix to Precedence matrix

The significance of each factor was evaluated on basis of increases in individual classes of roads and their interdependence. Linear functions have been developed based on a combination of weights and factors. Functional values were used as criteria for determining the precedence of the selected weights of the individual factors. Weight in the range of integers from 1 to 10 was assigned to each transport structure. Weight from the same range from 1 to 10 was also used to determine the significance of the relationship to the surroundings. Precedencies are determined on the basis of linear functions of 10 factors and their corresponding weights.

In process of modeling the measurement revealed that the sensitivity of the model to the weight of significance is negligible, so the linear function was limited to eight variables – motorways, exits, expressways, first, second and third class roads, changes to the surroundings in 2004–2008 and changes to the surroundings in 2009-2013. The following figure shows a part of combination of weights used in the analysis (selection alternative: Table 3). Variants 1–6 illustrate a case where the qualitative factors are dominant for the model. The largest weights are assigned to highways, expressways, first class roads and exits. In these variants there is a clear effect of weight by the relationships to surroundings created in 2009–2013. Change in the weight of this factor leads to an increase of the third precedencies in precedence frequencies (Botlík, Botlíková, 2012).

Table 3. Selected combinations of weights

Variant	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Highway	10	10	10	10	10	10	1	1	1	1	1	1	1	1	10	5	4	4	4	4
Downhill	10	10	10	10	1	1	1	1	1	10	10	10	1	10	10	2	5	5	5	5
Expressway	10	10	10	10	10	10	1	1	1	1	1	1	1	1	1	6	2	6	6	6
Class I.	10	10	10	1	10	10	10	10	10	10	10	1	1	1	1	4	4	6	6	6
Class II.	1	1	1	1	1	1	10	10	10	10	10	10	1	1	1	5	3	10	1	10
Class III.	1	1	1	1	1	1	10	10	10	10	10	10	1	1	1	9	6	8	8	1
Neighborhood 1	1	1	10	1	1	10	1	10	1	10	1	1	1	1	1	1	4	5	5	5
Neighborhood 2	1	10	10	1	1	10	1	1	10	1	10	1	1	1	1	7	3	10	10	10

Change in the weight of this factor leads to an increase of the third precedencies in precedence frequencies. If we apply the weights to the relationships to the surroundings in the whole interval 2004–2013, the influence is not evident. From this we can conclude that the system is more sensitive to changes in high-speed communications relative to surroundings in 2009–2013. If we do not include first class roads into high-speed communications, an increase in longer precedencies by the precedence frequencies will occur. This implies that the system is more sensitive to an increase in highways and expressways than to an increase in first class roads. Reduction of weight at motorway exits leads to an increase in the frequencies of second precedencies when the factor of influence to the surroundings is not taken into account. In case of maximal weight in the factor of influence on the surroundings and reduced weight at motorway exits, a decrease in slope and more gradual reduction of longer precedencies can be observed. Presented graphs show comparison in the Moravian-Silesian region segmented to municipalities with delegated powers (21 municipalities and vicinity). More about this is written (Botlík, Botlíková, 2013 b)

3.1. Analysis of percentage changes in infrastructure

Based on the documents from precedence matrices were created 56 maps (Botlík, Botlíková, 2013 a). For each of the fourteen county there are 4 maps. The meaning of those maps is the combination of two qualitative parameters (M+H, I–III) and two quantified parameters (percent of assets for the county, the sum of percentages for communication). Into the individual maps were entered routes where is the decreasing value of qualitative parameters of the quantifiable parameter. The calculated multiple precedence was recorded by using the graph. Regions with precedence were assigned a value of "max (existing precedence) – precedence (region)". In this graph it can clearly trace the paths with decreasing number of the precedence. In practice, these paths show the way to a steady decline in the communications according to the criteria. On the basis of these graphs were created maps, in which marked decreases have progressively darker shades. In general, from maps it is possible to trace a strong dominance of the Central and Southern Czech regions in all types of analyzes. This dominance is quite strictly segmented to the southeast of the Republic of South Moravian region (Figure 2, map 1) and the Central Bohemia region (Figure 2, map 2), where the precedencies M+H are due to the length of roads in the regions (darkest color is the longest precedence). More maps and data (Botlík, J., Botlíková, M., Andrýsek, L., 2013)

Fig. 2. Dominance of the regions

Dominance of the Central Bohemian region is also evident in other comparisons. For example the analysis of roads I–II categories in proportion to the total length of roads in the country, it is clear routing of precedence in Moravian regions and it is seen unflattering situation of Moravian and Zlín regions. The comparison of I. to III. class to the total length of roads in the region contains the regions Královehradecko and Pardubice region comparable by heading of precedence to the Czech regions with precedence Prague – Central Bohemian region – Pilsen region - Ústí region – Liberec region. If we evaluate class I to III. class to the total length of the type of communications in the country, then the region Královehradecko is more akin to the region of Vysočina routing to precedence of Moravian-Silesian regions.

In the analysis of highways´ length due to the length of the whole country is Moravian-Silesian region predecessor of Olomouc region, however, if we add to highways speed routes, then the situation is reversed. Dominance of highway D1 and D5 is obvious. These comparisons are made to demonstrate the methods and overall evaluation is beyond the scope of this article. The results will be published in a separate monograph (grant SGS 5/2013 OPF Karvina, SU, Opava).

4. Transport infrastructure funding

An integral part of the analysis is the selection of funding and financial resources. In case of national and transnational infrastructure, the Czech Republic and European Union resources are used. Part of the resources is distributed through funds.

4.1. Structural Funds (SF), Cohesion Fund (CF), national sources

The transport sector is implemented under the Operational Programme Transport (OP Transport) and Regional Operation Programme (Regional OP), according to the strategic document (MRD CZ, 2013) "National Strategic

Reference Framework of the Czech Republic 2007–2013" (NSRF). A quarter of the total allocation of the NSRF is allocated to activities aimed at developing the transport infrastructure, which demonstrates the importance of this section for the development of the Czech Republic. The development of transport infrastructure of international and national importance is supported within OP Transport, while supra-regional infrastructure and in particular infrastructure of regional importance is supported by Regional OP. Funds from SF/CF and from national sources in the amount of CZK 187.2 billion (24.6% of the overall allocation of NSRF) were designated to improve transport infrastructure in the 2007–2013 period. The largest portion of this amount is allocated for the development of the roads (58.5%) and rails (38.4%). A total amount of 574 applications for support to projects in the field of transport infrastructure with a total value of CZK 215.5 billion were applied until March 3, 2011. Approved funding by location, SF / CF and national sources (MRD CZ, 2013). This amount exceeds by 5.6% the total allocation intended for the development of transport infrastructure in the period 2007-2013. In 2012, authorities issued a total of 432 decisions/contracts to grant subsidies totaling 185.4 billion CZK, what is 99.0% of the overall allocation to the transport infrastructure. Expenditures were CZK 108.8 billion, i.e. 58.1% of the total allocation for transport infrastructure. Financially it was completed 265 projects with a total value of 38.8 billion CZK, which is 61.3% of projects and 20.9% of approved funds. Within priority axis (highway and road network, which is part of the trans-European network TEN-T), by third March 2011 there were submitted 10 applications with a total sum of 72.1 billion CZK (163.9% of allocation in axis 2.1) and within priority axis 4 (expressways and other first class road, which are not part of TEN-T network) there were given grants to 41 projects in total sum of 33.8 billion CZK (110.3% of allocation)

4.2. The State Fund for Transport Infrastructure (SFDI)

Fundamental financial source for the implementation of transport infrastructure projects is the State Fund for Transport Infrastructure (SFDI). A significant reduction is reported in the volume of available funds. SFDI budget and its medium-term outlook disregarded the presumption of financial frameworks for the year 2011 as well as for the period 2012–2013 (Table 4). Because of the reduction in expenditure frameworks compared to the originally set values for the period of 2011 by 3.1 billion CZK and also the reduction of the budget SFDI due to reduction in EU funds, a significant decline in short-term plan for the construction of transport infrastructure occurred. The main parameter of the development of SFDI financial base in this proposal is to reduce the budget by approximately CZK 35 billion in 2011 and consequently only a very slight increase in the coming years.

Table 4. SFDI budget of 2011, a summary of 2009–2011, the medium-term outlook in the year 2012–2013

SFDI – Income and expenditure (KCZ $10^{3)}$	2010	2011	Proposal 2012	outlook 2013	outlook 2014
total revenue	96.02	61.29	47.24	61.96	57.14
of which: tax revenue and fee income	16.20	16.10	15.80	15.80	15.80
Non-tax and capital revenues (revenues from toll)	7.30	6.00	10.22	12.14	12.26
received subsidies	72.52	39.19	21.22	34.03	29.08
of which: transfers of income from privatized assets and dividends from companies with state partic.	5.10	0.83	0.00	0.00	0.00
subsidies from the state budget to cover the deficit	7.50	10.07	10.98	9.06	8.94
subsidies from the state budget for EU projects (OPD, KP, OPLZZ)	36.06	18.07	6.50	19.29	15.57
subsidies from the state budget for EU projects (EIB loan / new source)	12.21	10.21	3.74	5.67	4.56
subsidies from the state budget from the state bonds according to Act No. 220/2003	11.65	0.00	0.00	0.00	0.00
loans, bonds	0.00	0.00	0.00	0.00	0.00
total expenditure	96.02	61.29	55.01	61.96	57.14
of which: expenditures of national resources	36.10	33.00	37.00	37.00	37.00
expenditures of national resources from state bonds according to Act No. 220/2003.	11.65	0.00	0.00	0.00	0.00
expenditure on a project of EU - Operational Program Transport	35.91	17.97	14.18	19.29	15.57
EU projects co-financing (loan EIB / new source)	12.21	10.21	3.74	5.67	4.56
expenditure on EU proj. – Community Prog. and Op. Prog. Human Resources and Employment	0.15	0.11	0.09	0.00	0.00
balance of revenues and expenditures	0.00	0.00	–7.78	0.00	0.00

Funding for pre-events that are paid from available funds SFDI are not included in the above values. SFDI revenues are net of claims from 2011 in the amount of 7,775,000 thousand CZK (subsidies from the state budget for EU projects). New sources of OPD funding since 2013 are included under a project of EU co-financing (EIB loan / new source). In the balance of income and expenditure are claims from 2011. SFDI budget in this period responds to

the state's liabilities arising from the ongoing programs of transport infrastructure construction, which were based on the originally planned budget frameworks. Due to the reduction of expenditure frameworks in previous years compared to the originally specified values (from 47 billion to 37 billion, i.e. 10 billion CZK) there was a significant decline of 10 billion CZK (i.e. up to CZK 57 billion to CZK) in the spring of 2011 in the plan of construction of transport infrastructure against the medium-term outlook (Table 5).

Table 5. SFDI budget of 2012, the medium-term outlook till the year 2013–2014

SFDI – Income and expenditure (KCZ 10[3])	2009	2010	2011	outlook 2012	outlook 2013
total revenue	73.1	96	61.3	68.4	65.8
of which: tax revenue and fee income	17	16.2	16.1	16.1	16.2
Non-tax and capital revenues (revenues from toll)	4.4	7.3	6	10.1	10.2
received subsidies	51.7	72.5	39.2	42.2	39.4
of which: transfers of income from privatized assets and dividends from companies with state part.	4.4	5.1	0.8	0	0
subsidies from the state budget to cover the deficit	10.9	7.5	10.1	20.8	20.6
subsidies from the state budget for EU projects (OPD, KP, OPLZZ	26.5	36.1	18.1	16.2	13.5
subsidies from the state budget for EU projects (EIB loan / new source)	10	12.2	10.2	5.2	5.3
subsidies from the state budget from the state bonds according to Act No. 220/2003.	0	11.7	0	0	0
loans, bonds	0	0	0	0	0
total expenditure	73.1	96	61.3	68.4	65.8
of which: expenditures of national resources	36.7	36.1	33	47	47
expenditures of national resources from state bonds according to Act No. 220/2003.	0	11.7	0	0	0
expenditure on a project of EU - Operational Program Transport	26.4	35.9	18	16.1	13.5
EU projects co-financing (loan EIB / new source)[1]	10	12.2	10.2	5.2	5.3
expenditure on EU proj. – Community Prog. and Op. Prog. Human Resources and Employment	0	0.2	0.1	0.1	2.2

Crisis alternative operates with an increase of 2 billion CZK, i.e. the reference value of 49 billion CZK in each year. SFDI budget and medium-term outlook for years 2013 - 2015 is based on financial frameworks set by the Government of the Czech Republic for 2013, on medium-term outlook for years 2014 and 2015 and on the results of interdepartmental comment procedure. Budget primarily responds to the state's liabilities arising from the ongoing programs of transport infrastructure construction and aims to utilize the Operational Programme Transport 2007–2013 to the maximum possible extent.

Table 6. SFDI budget for 2013, medium-term outlook from 2014 to 2015

SFDI – Income and expenditure (KCZ 10[3])	2011	2012	proposal 2013	outlook 2014	outlook 2015
total revenue	61.29	85.27	58.60	37.00	37.00
of which: tax revenue and fee income	16.10	15.80	16.60	16.80	16.80
Non-tax and capital revenues (revenues from toll)	6.00	10.22	8.30	8.40	8.70
received subsidies	39.19	32.25	33.70	11.80	11.50
of which: transfers of income from privatized assets and dividends from companies with state part.	0.83	0.00	0.00	0.00	0.00
subsidies from the state budget to cover the deficit	10.07	14.98	12.67	11.80	11.50
subsidies from the state budget for EU projects (OPD, KP, OPLZZ	18.07	13.53	15.02	0.00	0.00
subsidies from the state budget for EU projects (EIB loan / new source)	10.21	3.74	0.00	0.00	0.00
subsidies from the state budget for EU projects (cofinancing)	0.00	0.00	6.00	0.00	0.00
loans, bonds	0.00	0.00	0.00	0.00	0.00
total expenditure	61.29	66.06	58.60	37.00	37.00
of which: expenditures of national resources	33.00	41.00	37.57	37.00	37.00
expenditure on a project of EU - Operational Program Transport	17.97	21.26	15.00		0.00
expenditure on a project of EU - new EU financial perspective (2014-2015)	0.00	0.00	0.00	0.00	0.00
EU projects co-financing (loan EIB / new source)	10.21	3.74	0.00	0.00	0.00
EU projects co-financing	0.00	0.00	6.00		
expenditure on EU proj. – Community Prog. and Op. Prog. Human Resources and Employment	0.11	0.66	0.03	0.00	0.00
balance of revenues and expenditures	0.00	7.80	0.00	0.00	0.00

Concerning the budget, there is a real danger of under-funding and lack of OPD coverage of financial resources, especially in 2014 and 2015, when sources from OP Transport will be excluded, so the budget will be only 37 billion CZK (Table 6). Because the resources are bounded by European funds, national actions that may not be a priority in terms of targeting EU support cannot be implemented. The current level of SFDI budget for 2014 and 2015 would not allow drawing funds from the new EU financial perspective in these years, because it would not be possible to ensure sufficient national resources for co-financing of EU funds. Strategic plan for 2013 and the medium-term outlook for 2014–2015 is aimed to ensure 100% depletion of the Operational Programme Transport 2007–2013, because EU subsidies are a unique, time- and factually limited resources and to prepare for EU

programming period in the period 2014–2020. Budgetary outlook assumes national resource of 37 billion CZK, does not count with the resources from European Investment Bank (EIB), which means that the total income of the loan will not be fully depleted (by about 6.8 billion CZK). Due to the lack of resources for co-financing budget does not take into the account the sources of the new EU financial perspective 2014-2020 for investment in road and rail infrastructure. Due to the fact that in 2015 the possibility to use resources from OPD 2007–2013 ends, covers breakdowns of spending the whole allocation of this program, the amounts drawn down in previous years are already included. In connection with the financing of the EU since 2014, the Ministry of Transport is preparing a comprehensive strategic document "Transport Sector Strategy, second phase" in accordance with the requirements of the European Union. Transport Sector Strategy, second phase (DSS2 or simply Transport strategy) defines principles for effective and quality assurance of operation of existing transport infrastructure and provides principles for determining the priorities for planned development projects with particular financial framework. The document presents the basic concept of Ministry of Transport outlining priorities and objectives for the development of transport and transport infrastructure in the medium-term to 2020 and also more generally in the long term until 2050.

Table 7. Financial performance of the developing actions on the road network

bil. CZK	projects	proposals
Construction of new sections of highways	79.95	-----
Construction of new sections of expressways	305.08	245.4
Modernisation of class I roads	13.6	18.38
Capacity increase and modernization of motorways and expressways	56.9	1.86
Construction of bypasses and road relocations Class I.	148.79	212.8
Package category A1	604.37	478.46

Sector strategies there were taken into account legislative and non-legislative documents of the EU, mainly Europe 2020 – A strategy for smart, sustainable and inclusive growth, KOM (2010) 2020 and the White Paper – Roadmap to a Single European Transport Area – Towards a competitive and resources efficient transport system, KOM (2011) 144. The following Tables 7 and 8 show the cost of the roads (A1 set – development of motorways, expressways and first class roads). These tables, together with budgets in the period of 2009–2014 are the basis for the precedence analysis of transport funding.

Table 8. Prognosis of ideal needs of the total annual costs of the rail network operability

	2012	2015	2020	2035	2050
Length of rated networks [km]	9260	9255	9230	9410	9618
Maintenance work [bil. CZK]	4.054	4.102	4.185	4.904	5.639
Repair and reconstruction [bil. CZK]	4.054	4.102	7.819	16.85	19.427
Total operability [bil. CZK]	8.108	8.204	12.003	21.754	25.066

4.3. The possibility of using EU funds for financing DI (I OPT, OPT II, CF, ERDF, CEF)

Operational Programme Transport 2007–2013 (OPT I) allows financing investment projects in 2014 and 2015 using the "n +2" rule. The need and opportunity for consumption of allocation OPT I thus coincides with the form of medium-term transport strategy period 2014–2020. Consumption of allocation OPT I is necessary to consider as a priority in 2014 and 2015. Therefore, the implementation schedule of transport strategy covers these projects. For the large projects OPT I, which will not be completed by the end of 2015, it will be necessary to take advantage of their phasing, i.e. the completion of the project by the use of FS in the period starting in 2016 or with the use of national resources by the current budgetary possibilities of the years.

Cohesion Fund – CF. In the period 2014–2020 this fund will form the major part of the available EU funds for the country. It will be able to finance projects for the trans-European transport network (main and global network TEN-T), in the case of railways can also finance projects outside the TEN-T. The effective interest rate is assumed by the EU of 70%, i.e. need for national funds for co-financing of 30%.

Connecting Europe Facility – CEF. In the total allocation of EU funds there is defined the cohesion and the European part, it is one of the most important innovations of the future programming period 2014–2020. The

cohesion part resources can only be used for financing major projects of the TEN-T rail and water transport. In the case of road projects they must be a cross-border nature. The conditions necessary for national co-financing share will be set as in the case of FS. The principles of the European part are built on the current TEN-T.

European Regional Development Fund – ERDF can be used for financing the development of any transport infrastructure outside the TEN-T network, including transport infrastructure projects for the promotion of tourism and recreation. (MRD CZ 2013) below summarizes the assumptions of potential sources of EU funding for the next programming period 2014-2020. According to current information from May 2013 there could be available about 125 billion CZK for the Czech Republic from EU funds for use in the transport sector. If the exchange rate CZK / EUR will strengthen (contrary to the long-term prediction of MF), it will mean the possibility of implementing a slightly increased volume of investment projects than it is planned.

5. Assumptions for investment prediction

Based on the expected fiscal situation in the Czech Republic in 2016, by (Zahradník, 2012), there should appear two fundamental, mutually conditioned phenomena. It should show a steady, crisis unaffected, economic development about 3.5%–4.0% year on year, which should contribute to the process of reducing the balance of at least CZK 30 billion annually. On the other hand, there is a commitment to reach equilibrium in the government sector by 2016. From this perspective, therefore, the proposed 30 billion annual deficit reduction would not be sufficient and it would take more stringent strategy. Under this assumption, we can expect a continuation of restrictive fiscal policies. For this purpose, it is desirable to politically enforce that during the launching of the new financial perspective and a new period for Cohesion policy, there was part of the public funds budgeted for transportation as a priority. Assuming recovery of public finances there may occur a slight let-up fiscal tightening by 2020. If economic output ensures adequate and predictable characteristics, cyclical contribution to the revenue side, keeping the low reformed expenditure side, achieved fiscal discipline should be sustainable, as measured by a balanced pointer. In this period it will be important that the debt burden of any budget surpluses will be spent on public debt amortization expense for fiscal expansion activities (after the restrictive period), which could occur in the form of a high degree of complementarity in the form of support Cohesion Policy instruments. The problem may be some parameters of very long-term fiscal sustainability (2060). These are measurable indicators S1 and S2. Indicator permanent fiscal consolidation S1 is expresses as per cent of GDP needed to permanently increase taxes or cut spending to government debt at the end of the period amounted to 60% of GDP. The S2 indicator reflects the level of fiscal effort to achieve equality of discounted revenues and expenditures for an indefinite term. The indicator of demographics evolution plays an important role in both indicators. For the Czech Republic the value of the indicator S1 is 5.3% of GDP (better than the EU average), the indicator S2 then 7.4 % of GDP, almost one percentage point above the EU average.

5.1. Financing of transport infrastructure, status and perspectives

By (Švagr, 2012) is a key factor in the lack of critical resources for the financing of transport infrastructure. It has been pointed out here that the situation will get worse in the future, there is a real risk of under-allocation of the Operational Programme Transport, the Czech Republic encountering errors in projects co-financed from EU funds, which led to the suspension of certification of expenditure by the European Commission, and do not have sufficient ownership and project construction ready for the new programming period of the EU funds in 2014–2020. These factors may prevent long-term sustainability of funding. Transport Operational Programme (OPD) is due to its allocation of about 171 billion CZK (European + national resources) by volume the largest program in the country. According to the monitoring report of the Ministry of Regional Development from April 2012 has been so far paid from OPD almost CZK 123 billion, i.e. 71% of allocated funds. Certified (i.e. approved), however, was only 29 billion CZK, i.e. less than 17%. The key factor for the current drawing from OPD is the fact that in March 2012 there was interrupted submission of payment claims for reimbursement by the European Commission for all operational programs co-financed by the European Regional Development Fund and the Cohesion Fund, due to deficiencies in the functioning of Czech management and control systems. At stake is thus pumping up to 20 billion CZK, which may thus remain outstanding from European funds. With regards to the outlook for the future funding

sources, according to SFDI there is assumption of stagnation, respectively decreasing trend. The adjusted budget for 2012 SFDI anticipated expenses in the amount of CZK 66 billion in 2013 counted 62 billion CZK in 2014 to 55 billion CZK in 2015 to 43 billion CZK. Just for comparison, it may be noted that the approved budget SFDI 2010 stood at 96 billion CZK. The projected decline in resources, more than 50% between 2010 and 2015 is entirely inappropriate. It negatively affects the outlook for the preparation of the new programming period for EU funds in the years 2014–2020 and does not allow compulsory co-financing of European projects. According to the Ministry of Transport from 2014 in terms of sources of funding transport projects the Connecting Europe Facility will have 21.7 billion and the Cohesion Fund 24 billion EUR; in the European Regional Development Fund there will be set aside 0.5 billion.

6. Conclusion

Conclusions of prediction conclusions are the same as stated (CEBRE, 2013). Connecting Europe Facility (CEF) will be implemented within the framework of the TEN-T and helps to realize the ambitions stated in the White Paper on transport. Allocation of CEF will be made complementary and integral to the structural funds as the Cohesion Fund and the European Fund for Regional Development. At the same time the role of the European facility will be to use finance more effectively by developing a systematic effort to involve private sector investment in transport infrastructure financing. “Transferred amount of EUR 10 billion from the Cohesion envelopes for the Czech Republic should not be in any way a threat but an opportunity, as it will implement a number of projects for the use of the financial envelope” (Ouaki 2013),. CEF is an opportunity to mobilize private investment in transport infrastructure. “Although you can generally perceive public private partnership (PPP projects) as complex and expensive, most of them implemented in Western countries have been successful.” (Kašík, 2013). In the period 2014–2020 Structural Funds will still be the most important source of funding for transport projects for the Czech Republic. The priority axes of OP Transport will allow the flexibility to use the funds that would otherwise not be possible to run out. Investment priorities are defined in the transport sector strategies II (medium-term plan for the development of transport infrastructure for the long term 2014–2020). In terms of the transport sector creation of a new facility CEF (Connecting Europe Facility) in the new financial perspective is the most important change for the Czech Republic. The current means of the TEN-T will also be part of the CEF and will be given to projects from across the EU, with a significantly higher share of national co-financing. Financing projects from EU funds after 2014 may be at risk if there are not allocated sufficient resources to prepare them, so that they can actually start, if approved for funding. Especially, it cannot begin drawing funds from new EU financial perspective from 2014, as the budget SFDI lacks of resources at the national co-financing of EU resources. MD and STIF, however, ask the beneficiary for project preparation for the new financial perspective so that their implementation was possible in the years 2014 and 2015. The condition for the start of pumping, however, are resources for co-financing. Funding for transport infrastructure are based on multi-source system and its correct settings, given the economic conditions of the Czech Republic, the EU and the available financial resources of the banking sector. This implies the need for the introduction and use of the instrument PPP projects. Insufficient allocation of funds under the Operational Programme is so threatened by pumping of more than CZK 20 billion, for 2014-2020 there is not enough prepared projects for constructions. Budgeting and finding sources of financing must be based on a system approach. One possibility for partial analysis is finding correlating parameters that enable the creation of a mathematical model of financing. The problem is the mathematical interpretation of disparate variables such as length of roads, the amount of freight, cost or investment. The starting point may be a precedent model. In this model, a comparison is made of the selected variables and the decrease or increase of values in relationally linked object can determine the effect of changes in the relevant variables in the vicinity of monitored objects. These increases in binary form are characteristic only by a single property – direction of relation. Determination of functions for correlation analysis is based on the principles of multi-criteria analysis. This is a simplified form of the finding of the function F (x, y, z...), where the variables are given source of finance. If used simplest variant, i.e. a linear function, it would be to find the coefficients of the relevant investment of resources that would indicate to the available quantity and the quantity used. Budgets in transport infrastructure can be used as primary source for the analysis (Table 4–8). This data can

further specified by the individual sub-resources budget. Correlations and trends can be compared with really pumped finance and real changes in infrastructure.

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